

Modulus stabilisation in a backreacted warped geometry model via Goldberger-Wise mechanism

Ashmita Das*

*Department of Physics, Indian Institute of Technology,
North Guwahati, Guwahati, Assam 781039, India*

Tanmoy Paul† and Soumitra SenGupta‡

*Department of Theoretical Physics,
Indian Association for the Cultivation of Science,
2A & 2B Raja S.C. Mullick Road,
Kolkata - 700 032, India.*

In the context of higher dimensional braneworld scenario, the stabilisation of extra dimensional modulus is an essential requirement for resolving the gauge hierarchy problem in the context of Standard Model of elementary particle Physics. For Randall-Sundrum (RS) warped extra dimensional model, Goldberger and Wise (GW) proposed a much useful mechanism to achieve this using a scalar field in the bulk spacetime ignoring the effects of backreaction of the scalar field on the background metric. In this article we examine the influence of the backreaction of the stabilising field on the stabilisation condition as well as that on the Physics of the extra dimensional modulus namely radion. In particular we obtain the modifications of the mass and the coupling of the radion with the Standard Model (SM) matter fields on the TeV brane due to backreaction effect. Our calculation also brings out an important equivalence between the treatments followed by Csaki et.al. in [18] and Goldberger-Wise in [8, 17].

INTRODUCTION

The gauge hierarchy problem in SM of particle Physics results into the well known fine tuning problem in connection to the Higgs mass which acquires a quadratic divergence due to the large radiative correction in perturbation theory. In order to confined Higgs mass parameter within TeV scale, one needs to consider theories beyond the SM of particle Physics. Among many such attempts [1–7], Randall-Sundrum (RS) warped extra dimensional scenario has earned special attention for following reasons [3]:

- It resolves the gauge hierarchy problem without introducing any other intermediate scale in the theory.
- The modulus of the extra dimension can be stabilised by introducing a bulk scalar field[8].

Warped solutions, similar to RS model, can also be found from string theory which predicts inevitable existence of extra dimensions [9].

In search for such extra dimensions, the detectors in LHC [10, 11] have been designed to explore possible signatures of the warped geometry models through phenomenology of RS graviton [12–16], radion [17–20] and RS black holes [21–23].

One of the crucial aspect of this braneworld model is to stabilise the distance between the two branes (known as radius modulus or radion). For this one needs to generate an appropriate potential term for the radion field with a stable minimum consistent with the value proposed in RS model in order to solve the gauge hierarchy problem. Goldberger and Wise proposed a very useful mechanism to achieve this by introducing a bulk scalar field with appropriate boundary terms. They showed that one can indeed stabilise the modulus without any unnatural fine tuning of the parameters when the effects of the backreaction of the bulk scalar on the background metric can be ignored. Subsequently the phenomenology of the resulting radion field as a fluctuation about this stable minimum of the modulus became an important area of study specially in the context of collider phenomenology of extra dimensional scenario beyond Standard Model of particle Physics.

The important questions that however remain are,

- when the energy momentum tensor of the bulk scalar is significantly large so that it's backreaction on the bulk 5-dimensional metric can not be ignored, can we still stabilise the modulus following GW prescription ? What is the resulting stabilisation condition?
- If the modulus is stabilised, how does the mass and couplings of the radion field change due to the backreaction effect?

We aim to address these questions in this work. After a brief review of RS model, we obtain the modulus potential generated by integrating the bulk scalar field action

* ashmita@iitg.ernet.in

† tpap@iacs.res.in

‡ tpssg@iacs.res.in

in a fully backreacted 5-dimensional metric. We explicitly find the expression for the radion minimum which matches with that proposed in [18] where our result additionally determines the exact form of the boundary value of the scalar field at the TeV brane. We also obtain the radion mass and coupling with standard model field following the procedure proposed in [17]. We conclude by comparing our results with that obtained in [18].

BRIEF DESCRIPTION OF RS SCENARIO AND ITS STABILISATION VIA GW MECHANISM

RS scenario is defined on a five dimensional spacetime involving one warped and compact extra spacelike dimension. This scenario postulates gravity in the five-dimensional ‘bulk’, whereas our four-dimensional universe is confined to one of the two 3-branes known as TeV/visible and Planck/hidden brane located at the two orbifold fixed points along the compact dimension. The RS model is characterised by the non-factorisable background metric,

$$ds^2 = e^{-2kr_c|\phi|} \eta_{\mu\nu} dx^\mu dx^\nu - r_c^2 d\phi^2 \quad (1)$$

The extra dimensional angular coordinate is denoted by ϕ and ranges from $-\pi$ to $+\pi$ following a S^1/Z_2 orbifolding. Here, r_c is the compactification radius of the extra dimension. Two 3-branes are located at the orbifold fixed points $\phi = (0, \pi)$. The quantity $k = \sqrt{\frac{-\Lambda}{12M^3}}$, which is of the order of 5-dimensional Planck scale M . Thus k relates the 5D Planck scale M to the 5D cosmological constant Λ .

The hidden and visible brane tensions are, $V_{hid} = -V_{vis} = 12M^3k$. All the dimensionful parameters described above are related to the reduced 4-dimensional Planck scale M_{Pl} as,

$$M_{Pl}^2 = \frac{M^3}{k} (1 - e^{-2k\pi r_c}) \quad (2)$$

For $k\pi r_c \approx 36$, the exponential factor present in the background metric, which is often called warp factor, produces a large suppression so that a mass scale of the order of Planck scale is reduced to TeV scale on the visible brane. A scalar mass say mass of Higgs is given as,

$$m_H = m_0 e^{-k\pi r_c} \quad (3)$$

Here, m_H is Higgs mass parameter on the visible brane and m_0 is the natural scale of the theory above which new physics beyond SM is expected to appear [3].

In higher dimensional braneworld scenario, the stabilisation of extra dimensional modulus is a crucial aspect and needs to be addressed carefully. It has been demonstrated by Goldberger and Wise that the modulus corresponding to the radius of the extra dimension in RS warped geometry model can be stabilised [8] by invoking

a massive scalar field in the bulk. Consequently the phenomenology of the radion field originating from 5D gravitational degrees of freedom has also been explored [17]. GW mechanism for stabilisation postulates a bulk scalar field with different vacuum expectation values (VEV) at the two 3-branes that reside at the orbifold fixed points of S_1/Z_2 compactification. This mechanism, however, generates a bulk energy density which may modify the warped geometry itself via backreaction. Though this had been neglected in the initial GW proposal, its various implications, including the modifications of the warp factor, have been subsequently investigated [18, 20]. The authors of [18] have explored the radion phenomenology in the background of the backreacted RS warped geometry model assuming the boundary values of the scalar field at the two branes. They proposed that the extra dimensional modulus will be stabilised at $k\pi r_0 = \frac{k}{u} \ln(\frac{\Phi_P}{\Phi_T})$ where r_0 is the stabilised value of the modulus, u is the quartic coupling parameter in the bulk scalar field potential and Φ_P, Φ_T are the boundary values of the scalar field at the two orbifold fixed points where the Planck and TeV branes are located.

In this work, we want to explore whether the modulus stabilisation of such backreacted warped scenario can also be analysed via GW mechanism with a quartic potential for the stabilising scalar field in the bulk as described in [18]. Considering the quartic form of potential for the bulk stabilising scalar field, we further explore the radion phenomenology in this background model by using the technique as explained in [17]. We then compare our results with [8, 17, 18]. We organise our work as follows: In section I, we describe five dimensional warped geometry model which includes the effect of the backreaction of the bulk stabilising scalar field on the background geometry. In section II, we explain the stabilising mechanism of this backreacted warped geometry model by using the GW mechanism. In section III, IV, we find the radion mass and its coupling with the SM matter fields on TeV brane which bring out the modifications of these due to back-reaction effect.

I. BACKREACTED RANDALL-SUNDRUM MODEL

We consider the action for this background geometry as,

$$\begin{aligned} S = & -M^3 \int d^5x \sqrt{G} [R - \Lambda] \\ & + \int d^5x \sqrt{G} [(1/2) G^{MN} \partial_M \Phi \partial_N \Phi - V(\Phi)] \\ & - \int d^4x \sqrt{-g_{hid}} \lambda_{hid}(\Phi) - \int d^4x \sqrt{-g_{vis}} \lambda_{vis}(\Phi) \end{aligned} \quad (4)$$

where M is the five dimensional Planck scale, G_{MN} is the five dimensional metric where g_{hid} and g_{vis} are the induced metric on hidden and visible brane respectively. Λ symbolises the bulk cosmological constant, Φ is the scalar

field and $V(\Phi)$ is the scalar field potential. λ_{hid} , λ_{vis} are the self interactions of scalar field (including brane tensions) on Planck, TeV branes. We consider the background metric ansatz as,

$$ds^2 = \exp[-2A(\phi)]\eta_{\mu\nu}dx^\mu dx^\nu - r_c^2 d\phi^2 \quad (5)$$

where $A(\phi)$ is the warp factor. For simplicity we assume that the bulk scalar field depends only on the extra dimensional coordinate (ϕ). Thus the 5-dimensional Einstein's and scalar field equations for this metric can be written as,

$$\frac{4}{r_c^2}A'^2(\phi) - \frac{1}{r_c^2}A''(\phi) = -(2\kappa^2/3)V(\Phi) - (\kappa^2/3)\sum \lambda_i(\Phi)\delta(\phi - \phi_i) \quad (6)$$

$$\frac{1}{r_c^2}A'^2(\phi) = \frac{\kappa^2}{12r_c^2}\Phi'^2 - (\kappa^2/6)V(\Phi) \quad (7)$$

$$\frac{1}{r_c^2}\Phi''(\phi) = \frac{4}{r_c^2}A'\Phi' + \frac{\partial V}{\partial \Phi} + \sum \frac{\partial \lambda_i}{\partial \Phi}\delta(\phi - \phi_i) \quad (8)$$

Where $M^3 = (1/2\kappa^2)$. Here index i is used to designate the two branes and prime denotes the derivative with respect to ϕ . From the above equations, the boundary conditions of $A(\phi)$ and $\Phi(\phi)$ are obtained as,

$$\frac{1}{r_c}[A'(\phi)]_i = (\kappa^2/3)\lambda_i(\Phi_i) \quad (9)$$

and

$$\frac{1}{r_c}[\Phi'(\phi)]_i = \partial_\Phi \lambda_i(\Phi_i) \quad (10)$$

Square bracket in the above two equations represents the jump of the variables $A'(\phi)$ and $\Phi'(\phi)$ at the branes. In order to get an analytic solution of backreacted Randall-Sundrum scenario, let us consider the form of the scalar field potential as [18],

$$V(\Phi) = (1/2)\Phi^2(u^2 + 4uk) - (\kappa^2/6)u^2\Phi^4 \quad (11)$$

where $k = \sqrt{-\kappa^2\Lambda/6}$. The potential contains quadratic as well as quartic self interaction of the scalar field. Moreover it may be noticed that the mass and quartic coupling of the field $\Phi(\phi)$ are connected by a common free parameter u . Using this form of the potential, one can obtain a solution of $A(\phi)$ and $\Phi(\phi)$ as follows,

$$A(\phi) = kr_c|\phi| + (\kappa^2/12)\Phi_P^2 \exp(-2ur_c|\phi|) \quad (12)$$

$$\Phi(\phi) = \Phi_P \exp(-ur_c|\phi|) \quad (13)$$

where Φ_P is taken as the value of the scalar field on the Planck brane. Moreover λ_{hid} and λ_{vis} can be obtained from the boundary conditions (eqn.(9) and eqn.(10)) as,

$$\lambda_{hid} = 6k/\kappa^2 - u\Phi_P^2 \quad (14)$$

$$\lambda_{vis} = -6k/\kappa^2 + u\Phi_P^2 \exp(-2u\pi r_c) \quad (15)$$

II. STABILISATION MECHANISM

We now address the modulus stabilisation using GW prescription by including the effects of the backreaction of the stabilising bulk scalar on the background geometry. We aim to determine how the backreaction can influence the stability of the braneworld.

Plugging the scalar field solution from eq.(13) into the five dimensional scalar field action and integrating over ϕ , we obtain an effective four dimensional potential for r_c as,

$$V_{eff}(r_c) = r_c \int d\phi \exp[-4A(\phi)][u^2\Phi_P^2 \exp(-2ur_c\phi) + (u^2 + 4uk)\Phi_P^2] \exp(-2ur_c\phi) - (\kappa^2 u^2/3)\Phi_P^4 \exp(-4ur_c\phi) + \exp[-4A(0)]u\Phi_P^2 - \exp[-4A(\pi r_c)]u\Phi_P^2 \exp(-2u\pi r_c) \quad (16)$$

The stabilised value for the inter brane separation can be achieved by minimising the low energy effective potential for the modulus field r_c . The minimisation of the low energy effective potential with respect to r_c can be obtained (by using Leibniz's theorem) as follows,

$$\frac{\partial V_{eff}}{\partial(\pi r_c)} = \exp[-4A(\pi r_c)] \exp(-2u\pi r_c) \quad (17)$$

$$[4u^2\Phi_P^2 + 8uk\Phi_P^2 - \kappa^2 u^2\Phi_P^4 \exp(-2u\pi r_c)] \quad (18)$$

From the above expression we obtain the stabilisation condition for the modulus field r_c as,

$$k\pi r_c = \frac{k}{u} \ln \left\{ \frac{\kappa\Phi_P}{2\sqrt{1 + \frac{2k}{u}}} \right\} \quad (19)$$

Equation(19) implies the stabilisation condition between the two 3-branes in the backreacted Randall-Sundrum set up. Comparing the scalar field solution (eqn.(13)) and the expression of stabilised modulus (eqn.(19)), the expression for the VEV of scalar field on TeV brane (*i.e* Φ_T) can be written as $\kappa\Phi_T = 2\sqrt{1 + \frac{2k}{u}}$. With this value of the scalar field on the TeV brane, eqn.(19) becomes $k\pi r_c = \frac{k}{u} \ln(\Phi_P/\Phi_T)$ which matches with that described in [18].

Our entire analysis of finding the stabilisation condition in eqn.(19) is valid only for $u > 0$. In this context one can easily check that $V_{eff}(r_c)$ produces no minima for $u < 0$. Hence the parameter u is confined in positive regime in order to make a stable configuration for this backreacted braneworld scenario.

As we have seen earlier that in order to stabilise RS braneworld scenario, GW in [8] has chosen a quadratic potential for the bulk stabilising scalar field. However the backreacted model that we have considered contains also quartic term of the bulk stabilising scalar field potential. If we keep only the leading order terms in u , the potential in eqn.(11) tends to a quadratic potential where the mass

of the scalar field (Φ) can be written as $m_\Phi^2 = 4uk$. In this limit the stabilisation condition becomes,

$$k\pi r_c = \frac{4k^2}{m_\Phi^2} \ln \left\{ \frac{\kappa\Phi_P}{2\sqrt{1 + \frac{2k}{u}}} \right\}$$

which is same as the expression for the stabilised modulus obtained in [8]. For u/k less than unity, we neglect the higher orders of u/k which in turn implies that the scalar potential contains only the mass term ($V(\Phi) = 2uk\Phi^2$ just as GW original work of stabilisation (see eqn.(11)). Furthermore, for small u/k , the ratio between the energy momentum tensor of the scalar field and of the bulk cosmological constant Λ goes as u/k which immediately justifies the assumptions made by Goldberger and Wise that the scalar field backreaction is negligible with respect to Λ . This explains why our final result of stabilised inter brane separation (eqn.(19)) converges exactly to the stabilised modulus expression obtained in [8] in the limit of small u/k parameter. However we emphasise that the expression in eqn.(19) is a generalised stabilisation condition including the full backreaction of the stabilising field.

III. RADION MASS

In this section, we consider a small fluctuation of the brane locations around the stable inter brane separation r_c which depends on the brane coordinates x^μ . The corresponding metric ansatz is,

$$ds^2 = \exp[-2A(x, \phi)] g_{\mu\nu}(x) dx^\mu dx^\nu - T^2(x) d\phi^2 \quad (20)$$

where $T(x)$ measures the inter brane fluctuations between the branes and ϕ is the extra dimensional angular coordinate.

The modified warp factor therefore can be written as,

$$A(x, \phi) = k|\phi|T(x) + \frac{\kappa^2\Phi_P^2}{12} \exp[-2u|\phi|T(x)] \quad (21)$$

In the four dimensional effective theory, $T(x)$ appears as an additional scalar field known as modulus field [17]. A Kaluza-Klein reduction of the five dimensional Einstein-Hilbert action for the above warp factor (eqn.(21)) leads to the kinetic term of $T(x)$ as follows:

$$\begin{aligned} S_{kin}[T] = 12M^3 \int d^4x \sqrt{-g} \int d\phi \exp[-2A(x, \phi)] \\ [k\phi\partial_\mu T \partial^\mu T (1 - \frac{\kappa^2\Phi_P^2}{6} \frac{u}{k} \exp(-2u\phi T)) \\ - k^2\phi^2 T \partial_\mu T \partial^\mu T (1 - \frac{\kappa^2\Phi_P^2}{6} \frac{u}{k} \exp(-2u\phi T))^2] \end{aligned} \quad (22)$$

Assuming that $\frac{\kappa^2\Phi_P^2}{6} \frac{u}{k}$ is less than unity such that $(1 - \frac{\kappa^2\Phi_P^2}{6} \frac{u}{k}) \simeq 1$, and integrating over the extra dimensional coordinate (ϕ), we obtain,

$$\begin{aligned} S_{kin}[T] = \frac{6M^3}{k} \int d^4x \sqrt{-g} \partial_\mu (\exp[-A(\pi, x)]) \\ \partial^\mu (\exp[-A(\pi, x)]) \end{aligned} \quad (23)$$

In order to obtain a canonically normalised radion field, we now redefine $T(x) \rightarrow \psi(x)$ where

$$\Psi(x) = \sqrt{\frac{12M^3}{k}} \exp[-A(x, \pi)] \quad (24)$$

With respect to this redefined field ($\Psi(x)$), the kinetic part of the action becomes canonical as,

$$S_{kin}[\Psi] = (1/2) \int d^4x \sqrt{-g} \partial_\mu \Psi \partial^\mu \Psi$$

Now we turn our focus to find the radion mass square (m_Ψ^2) from the following expression,

$$m_\Psi^2 = [V''_{eff}(T) * T'(\Psi)^2]_{(T=r_c)} \quad (25)$$

where r_c is the stabilized modulus (eqn.(19)) and $V_{eff}(T)$ is obtained from eqn.(16) by replacing r_c by $T(x)$. Therefore, we determine $V''_{eff}(T)$ and $T'(\Psi)^2$ at $T = r_c$ as follows,

$$V''_{eff}(r_c) = 2\kappa^2 u^3 \Phi_P^4 \exp[-4A(\pi r_c)] \exp(-4u\pi r_c)$$

$$T'(\Psi)^2|_{r_c} = \frac{1}{12M^3 k} \exp[2A(\pi r_c)]$$

where we use the assumption ($\frac{\kappa^2\Phi_P^2}{6} \frac{u}{k} < 1$) and $A(\pi r_c) = k\pi r_c + \frac{\kappa^2\Phi_P^2}{12} \exp(-2u\pi r_c)$. Putting these expressions into eqn.(25) we obtain the radion mass square as (taking $\frac{\kappa\Phi_P}{\sqrt{2}} = l$)

$$\begin{aligned} m_\Psi^2 = \left\{ \frac{8}{3k} u^2 l^2 (2k + u) \exp[-2(u + k)\pi r_c] \right. \\ \left. \{ \exp[-\frac{l^2}{3} \exp(-2u\pi r_c)] \} \right\} \end{aligned} \quad (26)$$

Thus, we obtain the mass of the radion field (following the procedure described in [17]) when the bulk scalar potential ($V(\Phi)$) contains quadratic as well as quartic self interaction of the scalar field (Φ). Our final result of radion mass (eqn.(26)) though resembles to the mass expression in [18] (eqn.(6.6)) however has an additional correction. This small correction arises because our assumption ($l^2 \frac{u}{k} < 1$) is slightly different from ($l^2 < 1$) which is considered by the authors of [18]. However, for $l^2 < 1$, our result exactly coincides with the radion mass expression given in [18].

Again, in order to find a correlation between these two different mechanism of finding radion mass namely in [17] and in [18], we determine the mass of the radion in the leading order of parameter u/k . As a result, eqn.(26) turns out to be,

$$m_\Psi^2 = \frac{4k^2\Phi_P^2}{3M^3} \epsilon^2 \exp(-2k\pi r_c)$$

where $\epsilon = m_\Phi^2/4k^2$. The above expression is same as the radion mass obtained in [17]. Earlier we showed that the stable value of the modulus also matched with [8] in the leading order of the parameter u/k

IV. COUPLING BETWEEN RADION AND STANDARD MODEL FIELDS

The radion field arises as a scalar degree of freedom on the TeV brane and has interactions with the Standard Model (SM) fields. From the five dimensional metric ansatz (eqn.(20)), it is clear that the induced metric on visible brane is $(\frac{\Psi}{f})^2 g_{\mu\nu}$ (where $f = \sqrt{12M^3/k}$) and consequently $\Psi(x)$ couples directly with SM fields. For example, consider the Higgs sector of Standard Model,

$$S_{Higgs} = (1/2) \int d^4x \sqrt{-g} (\Psi/f)^4 [(\Psi/f)^{-2} g^{\mu\nu} \partial_\mu h \partial_\nu h - \mu_0^2 h^2] \quad (27)$$

where $h(x)$ is the Higgs field. In order to get a canonical kinetic term, one needs to redefine $h(x) \rightarrow H(x) = \frac{\langle \Psi \rangle}{f} h(x)$. Therefore for $H(x)$, the above action can be written as,

$$S_{Higgs} = (1/2) \int d^4x \sqrt{-g} [(\frac{\Psi}{\langle \Psi \rangle})^2 g^{\mu\nu} \partial_\mu H \partial_\nu H - (\frac{\Psi}{\langle \Psi \rangle})^4 \mu^2 H^2] \quad (28)$$

where $\mu = \mu_0 \frac{\langle \Psi \rangle}{f} = \mu_0 \exp[-A(\pi r_c)]$. Considering a fluctuation of $\Psi(x)$ about its VEV as $\Psi(x) = \langle \Psi \rangle + \delta\Psi$, one can obtain (from eqn.(28)) that $\delta\Psi$ couples to $H(x)$ through the trace of the energy-momentum tensor of the Higgs field:

$$\mathcal{L} = \frac{\delta\Psi}{\Psi} T_\mu^\mu(H)$$

So, the coupling between radion and Higgs field become, $\lambda_{(H-\delta\Psi)} = \frac{\mu^2}{\langle \Psi \rangle}$. Similar consideration holds for any other SM fields. For example for Z boson, the corresponding coupling is $\lambda_{(Z-\delta\Psi)} = \frac{m_Z^2}{\langle \Psi \rangle}$. Thus the inverse of $\langle \Psi \rangle$ plays a crucial role in determining the coupling strength between radion and SM fields. In the present case, we obtain

$$\langle \Psi \rangle = \sqrt{\frac{12M^3}{k}} \exp(-k\pi r_c) \exp[-\frac{l^2}{6} \exp(-2u\pi r_c)]$$

Hence finally we arrive at,

$$\lambda_{(H-\delta\Psi)} = \mu^2 \sqrt{\frac{12M^3}{k}} \exp(k\pi r_c) \exp[\frac{l^2}{6} \exp(-2u\pi r_c)] \quad (29)$$

and

$$\lambda_{(Z-\delta\Psi)} = m_Z^2 \sqrt{\frac{12M^3}{k}} \exp(k\pi r_c) \exp[\frac{l^2}{6} \exp(-2u\pi r_c)] \quad (30)$$

Once again we observe the appearance of an additional correction to the coupling from that obtained in [18]. The correction, though small in general, can be significant for small values of ur_c in the parameter space. These couplings however become same as that obtained in [17] in the leading order of u/k . In summary, we obtain the stabilisation of a backreacted warped geometry model via the GW mechanism. In addition we study the radion phenomenology and obtain an equivalence to the results obtained in [17, 18].

CONCLUSION

Stabilisation of RS braneworld scenario is an essential requirement to study various implications of the presence of a warped extra dimension on particle phenomenology as well as cosmology and gravitational Physics. The stabilisation mechanism originally proposed by Goldberger and Wise considered a negligible backreaction on the background geometry. In a more generalized version, the modified warp factor due to the influence of backreaction of a bulk scalar on the background geometry was derived in [18] for certain class of scalar potentials with quartic self-interaction.

In this work we show that such a backreacted RS warped geometry model can also be stabilised via the GW mechanism. The new stabilisation condition for the modulus is determined and its dependence on the backreaction parameter is found. We also show that the radion phenomenology can be studied in this background via the mechanism followed in [17]. In the present work, the derived mass and coupling of radion have remarkable equivalence with the results obtained in [18], despite the difference in approaches between these two works. Moreover to find solutions to modified Einstein's equation and the scalar field equations in presence of the backreaction of the scalar field, a quartic form of scalar field potential have been considered in [18]. However the GW stabilising scenario assumes only a quadratic mass term in the scalar potential with negligible backreaction on the background geometry. Our result depicts a vital correlation between these two forms of potentials in the leading order of u . As a result the stabilisation condition, radion mass and coupling parameter in these two different formalism get correlated in the leading order of parameter u . Our results also bring out how the backreaction effects modify the mass and coupling parameters of the model resulting into modifications of the particle phenomenology on the visible 3-brane.

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